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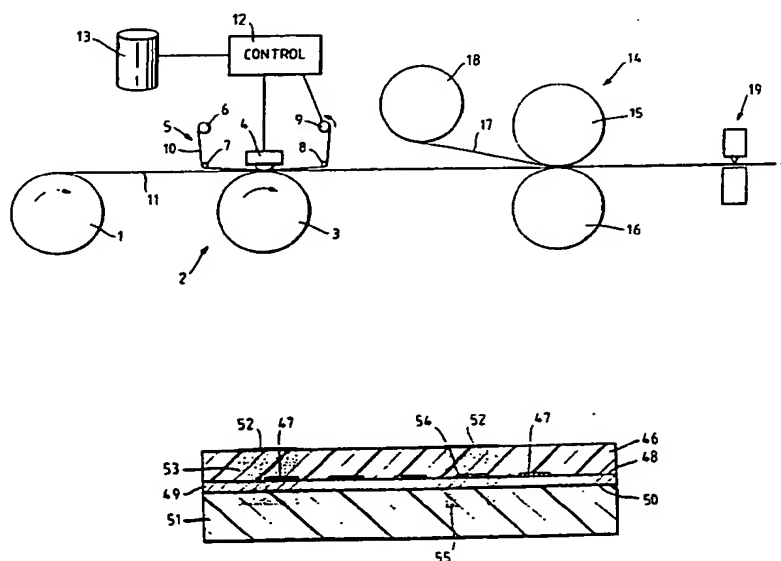
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(54) Title: IMAGING PLASTICS ARTICLES



(57) Abstract

A method of providing an image on an article including at least a first plastics layer (21). The method comprises transferring portions of at least one diffusible dye (22) on to the first plastics layer (21), the portions being selected so as to generate a representation of the image on the layer. The or each dye (22) is then caused to diffuse in to and partially remain in the first layer (21) and at least to mark and preferably diffuse in to a second layer (20) in contact with the first layer.

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Imaging Plastics Articles

The invention relates to providing images on plastics containing articles, for example as used in security articles.

Multiple layer plastics containing articles are used in a variety of fields but one particularly important application is in the field of security articles such as identification cards, credit cards, charge cards and the like. Such multiple layer plastics containing constructions are also used in passports, identity cards, driving licences, travel passes and the like, for example where a plastics film protects a photograph of the bearer. The article's security is enhanced when a tamperproof composite is made. Security printing of a general nature is generally included on an inaccessible internal layer. Identification or personalisation is conventionally added separately by including a photograph or signature or by embossing characters. By personalisation is meant the addition of features to a security item which serve to identify the holder of the item. These include monochrome and colour photographs, identification numbers, signatures, fingerprints and the like. Account information may also be added including the name of the account holder, the account number, etc. Other information such as the article's serial number and validity period may also be provided. At present photographs are normally adhered to a security printed surface and then laminated in place by the placement of an upper transparent film of PVC or other plastic layer.

As an alternative to the personalisation of cards, cards may be made individual for other purposes such as by being associated with one object from a similar range, eg. a vehicle. Cards may also be made individual with a view to allowing a group of people access to a service

without necessarily identifying group members e.g. airline boarding passes. The term "individual image" thus includes personalised images characteristic of a person as well as other forms of individualization.

5 In certain instances it may be necessary to produce a unique batch of cards and then validate the whole batch by applying an image immediately after the batch is taken from stock prior to issue. The batch members may also receive individual images.

10 Individual images by their nature are applied as a or the final production stage and it is essential to be able to change the images quickly. Electronic printing means are particularly suited for this as the alphanumeric and graphical image information can readily be changed.

15 It is already known to apply electronic images to security items. Known printing methods such as thermal printing, however, give colour images which are thin, suffering from the significant disadvantage that they may be abraded from the outside of the identity card.

20 Modern cash, charge and credit card production is increasingly centred on the use of polyvinyl chloride. The attractions of PVC are that it is inexpensive, embossable and fusion laminatable. PVC cards are therefore commercially significant. Embossability is necessary for allowing the card holder's particulars and account number to be included so that credit and charge card slips can be reliably and accurately printed with the above information at the time of a transaction.

30 The ability to produce satisfactory images on PVC is therefore liable to be commercially significant.

Certain forms of electronic imaging allow the use of dyes which may be sublimed or otherwise transferred onto a plastic receiving layer.

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It is known, however, that plastics have different efficiencies of receiving sublimed dyes. The receiving efficiency with regard to synthetic fibres, say, decreases from nylon to polyester to acrylic to acetate to polyvinyl acetate. Unfortunately, PVC is known to be a substrate of poor receptivity for sublimable dyes.

WO-A-8403257 describes a process for printing coloured designs onto a polymer surface. This is not suitable, however, where a large variety of different designs are required, each to be printed only once as in personalised data.

US-A-4738949 describes a dye transfer process for providing images on substrates. However, this technique has not been successful since only faint images can be obtained and there is also the problem that the transfer sheet can stick to the substrate leading to an unacceptable image being produced. - This patent is also not concerned with laminates made from polyvinyl chloride and its copolymers or blends.

DE-A-2413494 describes a thermal transfer process for transferring dyes to, inter alia, PVC sheets. However, this also suffers from various problems.

US-A-4507349 describes the imaging of security articles in which a barrier layer is provided to prevent dyes transferred on to a substrate from diffusing into other layers.

EP-A-97493 describes a colour formation technique in which a colourless dye diffuses into a receptor layer sufficiently to enable a complex to form.

It should also be noted that commercially available receiver sheets for thermal transfer printers frequently do not laminate successfully, probably owing to the presence of release layers and coatings. Such receiver sheets are often of complex construction.

In accordance with the present invention, a method of providing an image on an article including at least a first plastics layer comprises transferring portions of at least one diffusible dye onto the first plastics layer, the portions being selected so as to generate a representation of the image on the layer; and causing the or each dye to diffuse into and partially remain in the first layer and at least to mark a second layer in contact with the first layer.

We have found that for multiple layer articles including plastics layer(s), particularly certain grades of PVC, it is possible to provide good images on the article with adequate tone gradation and improved security by causing a controlled degree of diffusion of the dye into at least the first layer to occur while at least marking the second layer.

Typically, the diffusion step comprises applying heat (and optionally pressure) for a predetermined time to the article. In one example, the image may be provided on the underside of a transparent plastics film, diffusion being caused by applying a heated roller under pressure to the film and then adhering the film to a second layer which then allows the dye to mark it or preferably diffuse within it. This would be useful in the case of a passport where an image of the bearer could be provided on a film which is then adhered (laminated) to a security indicia printed paper page of the passport.

Preferably, the first layer is fusion laminated to the second layer, the at least partial diffusion of the or each dye being caused by the lamination step. This avoids the need for an adhesive so as to achieve a highly secure composite. The avoidance of dissimilar properties of the laminating components means that the interface has a high adhesive strength. It is not readily possible to force or peel apart the second layer.

and the topmost laminating film because they are chemically closely compatible and are essentially welded together. Lamination with adhesive is also possible, however.

5 By employing sublimable dyes which then diffuse into the plastics, the welding occurs over the image areas, i.e. there is plastics to plastics contact as distinct from, say, plastics to ink to plastics contact as in the majority of security articles of this type. This
10 welding greatly enhances the security of the article.

Preferably, the lamination step includes allowing the bonded laminate to cool under pressure. This maintains surface gloss and overall flatness. Typical pressures may be in the order of 300-600 lbs per square
15 inch (ie. 21kPa to 41kPa).

Typical fusion temperatures are between 130°C and 160°C. Pressure is used during lamination of the order of 20-150 pounds per square inch (ie. 1.4kPa to 10.4kPa). Under these conditions lamination is normally complete
20 within one minute.

We have found, for example, that by heating the dyes for about 30 seconds at 150 degrees Centigrade, penetration depths of the order of 30 microns have been obtained, which can be sufficient for the dyes to move
25 into receptor layers.

The novel diffusion aspect offers a high level of protection against fraudulent alteration as the dyes are contained within the bulk of one layer and at least mark the adjacent layer.

30 The dyes must be free to diffuse into the first plastics layer securing a significant degree of penetration. Documents may be given different dye images on both sides.

The diffusion of the dyes requires that the depths
35 of penetration achieved by the dyes is significantly

greater than would be the case with conventional thermally transferred dyes which are intended to bond principally on the surface or marginally within the receiver layer possibly around 5 microns. Laser transferred dyes are deposited more on the surface.

Generally the dyes for use with this invention will have low molecular weights as very high molecular weights reduce diffusivity. The dyes must be free to penetrate the plastics layer e.g. by thermal diffusion. This may involve diffusion within the polymer or alternatively there may be minute pores provided such as in having a porous particulate pigment present or minute vesicles.

In all cases the dye should be free to pass diffusively into the first (and if necessary, second) layer without significantly chemically associating with polymer, pigment or other additive.

Diffusion may occur during the imaging process or may be a separate process. Generally heat will be applied to a temperature below the softening point of the polymer. The heat may be applied by hot air, infrared radiation including laser radiation, or by contact with a hot surface which is preferably impervious to the dye. Thus for example there may be a metal plate applied to the surface of the first layer to which the dye has been applied, this being held in hot pressure contact so as to allow heat to be transferred by conduction. Such conditions occur during lamination of plastic to plastic and there may be no need to have a separate diffusion stage.

For continuous processes a heated roller having an impervious metal surface, passed over the substrate is suitable for causing diffusion of the dyes.

Alternatively, a plastic surface may be brought into contact with the imaged surface, the plastic being impervious to the dyes.

It is almost impossible to remove the dyes from the image receptive layer(s). Fraudulent scraping or erasure of the dyes from the surface will not permit total removal of the image as would be the case with conventional thermally applied images, which do not significantly diffuse into the image receptive layer. A diffused image will remain. This cannot be removed without damaging the laminated receptor film and any security printed indicia at the interface. Any attempt to place a fraudulent image on top of an earlier image will be readily revealed especially if it is associated with a security printed layer.

The electronically applied images will normally contain at least one of:

security indicia - generally comprising a selection of graphical designs, lineworks, lettering and number works, symbols, dots, guilloches - and issuing agency logos;

account information - comprising one or more of the name, address and account number of the holder, in alphanumeric characters;

item information - comprising one or more of the article's serial number and validity period in alphanumeric characters: and

personalising information - comprising one or more reproductions of the face, signature and fingerprint of the holder, people, groups, or objects, or other individualising information, or

encoding markings such as optically readable bar codes.

The images may also contain computer generated design elements.

In one example, the dye is applied to one surface of the first layer while the other surface of the first layer, ie. the surface which does not carry the

transferred dye or dyes is then laminated onto a second, plastics layer, the first layer being sufficiently thin that dye diffusion will occur through the first layer into the second layer. However, in the preferred example, the surface of the first layer carrying the transferred dye or dyes is laminated onto the second layer so that dye partially diffuses into both layers during lamination.

It is necessary that only one dye diffuses into the first layer or dye receptor layer, although if three dyes are applied it is preferable that all three diffuse, either to similar or different extents. The diffusion to different extents adds a security feature.

The marking in the second layer need not represent the whole image present in the first plastics layer e.g. where security printing is present the inks will be marked by the imaging dyes only -where the inks are present.

The first layer will generally be a polymeric material whether in a self supporting film, non-self supporting film on a carrier sheet or a coating. The coating may for example be applied to a plastic film, plastic sheet, plastic laminate, plastic paper laminate or coated paper surface. Dye may also be transferred to a smooth coated paper surface such as high quality printing papers for example on some identity cards.

Suitable laminatable films for receiving the dyes include polyvinyl chloride and polycarbonate. The film may if necessary be adhered to the second layer. The use of an adhesive is normally undesirable from the security aspect but use of adhesives allows many dissimilar layers to be bonded.

Suitable polymeric coatings for receiving diffusible dyes comprise polyvinyl chloride polymers, copolymers and blends, polycarbonates and polyesters.

Although for most purposes the dyes will be diffused in order to give a monolithic, tamperproof, structure, it is possible that a "peel apart" system could be used, for example allowing the outermost image receiving plastic film to be peeled off, say as a luggage label, while having a record on the backing sheet (e.g. airline ticket). In this case the plastic layer must be in clinging engagement with the second layer.

It is important that the dyes be matched to the first layer so that diffusion can occur. In general any dye electronically applied to the receptor sheet must diffuse in to a depth of at least 10 microns, preferably at least 20 microns, more preferably at least 25 microns, most preferably at least 50 microns, on heating for example to 150 degrees Centigrade for 30 seconds.

Heat (and optionally pressure) is applied to allow the dyes to diffuse into the polymeric receptor layer. If a heat lamination stage is involved e.g. when laminating a film to a plastic card substrate, the diffusion will occur during this stage without the necessity for a separate diffusion heating stage.

In a particularly preferred method, the second plastics layer includes previously printed indicia such that during the lamination step, the dye or dyes on the first layer diffuse to and through the printed indicia. This printed indicia may have been provided on a surface of the second layer or the second layer itself may comprise a lamination with the printed information being provided within the lamination while being visible externally of the second layer. In any event, this is particularly useful in the case of a security article where the printed indicia define a security print since any attempt to forge the security article (by replacing the image defined by the dye or dyes) will simultaneously cause destruction of the printed indicia.

A typical set of parameters which have been used are:

Temperature: 100° - 200 °
Pressure : 0 - 800psi (0-55kPa)
Times : ≤ 1 minute

5 By selection of appropriate combinations of temperature and pressure it has been possible to diffuse laser thermally transferred dyes through a 20 µm top layer of PVC coating, a layer of security print of 2 microns thick and finally marking the layer beneath. The
10 total depth of diffusion in this case was measured as about 52 microns.

Further experiments have resulted in depths of between 50 and 100 microns being measured, for example through three layers - plastic (20 microns): ink (2
15 microns): plastic core (e.g. 30 micron penetration).

One important application of this method is in the production of a security article in which case the image may comprise an indication of the bearer of the article such as an image of the bearer, an image of his signature
20 and the like. The term "image" however should be understood to include text characters and other types of information such as serial numbers, bar codes and other machine readable characters and codes.

25 In the case of security cards which typically comprise a relatively thick core and relatively thin cover layers, the first substrate could be provided by the core or one of the cover layers.

30 In addition to use in financial and identity plastic cards, the invention may be used, suitably adapted, on other security items such as passports, plastic surfaced identity cards, service entitlement cards, promotional cards, cheques, driving licences, voting cards, integrated circuit containing cards, and the like.

35 Thus for example passports normally have a film on the bearer's photograph page which protects the

photograph of the bearer. This film normally bears security markings and is adhered to the passport page with a heat activatable or cold seal pressure sensitive adhesive. Such a film may be imaged electronically by a method according to the invention. The film may be imaged either before or after adhering to the passport and then heated to ensure the dye diffuses into the film, preferably at least reaching the security layer. If necessary the film may be supplied on a peelable carrier.

The receptor layer may bear security indicia on either side if printing is feasible, in addition to any printing on the substrate to which it is attached.

The main use of the invention is in printing colour photographs of holders onto security items as there is no other way of readily doing this.

Thermally diffusible dyes may be placed on the receiving substrate by using an electronically driven imager which generates a radiation beam, such as a laser, or a printer having a multiplicity of individually heatable elements (ie. a printer having a thermal imaging head). In both cases a dye donor sheet or carrier is placed in close contact with the image receiving surface, and the laser beam or the thermal head element causes a point of dye to be transferred thermally to the dye receptive surface. The whole image is made from a multiplicity of individually applied points of dye. For a full colour image the process is conducted by sequentially transferring yellow, magenta, and cyan dyes.

At this stage, which is normally the final stage in thermal imaging, the deposited dyes reside essentially on the surface of the receptor and are not thought to penetrate more than about 2 microns. It should be understood that by thermal transfer we include various transfer methods such as those known as dye diffusion and dye sublimation. Those transfer methods should be

distinguished, however, from printing where a plate carrying the image is provided which is then coated with an ink before being impressed on a substrate.

5 Electronic laser imaging equipment employing a Nd:YAG laser suitable for use in the invention is described in EP 202811A. This is particularly useful for imaging the substrates which have been employed in this invention.

10 Thermal printing heads for use in thermal transfer printers are supplied by Mitsubishi, Dai Nippon, Fujitsu and TDK. Such heads are more readily adaptable to use with the less rigid laminating films. Such heads will generally allow a resolution of 150 to 300 points per inch.

15 The electronic imager may use images supplied from an electronic or video camera, a charge coupled device, a flat bed or rotary scanner or in the case of computer generated designs from a computer.

20 Thus one preferred method according to the invention comprises intimately contacting the dye releasing surface of a dye donor film with the first plastics layer, exposing the dye releasing layer to an image creating beam of laser radiation such that dye is then imagewise transferred to the plastics layer and then diffusing the dye into the plastics layer and adjacent second layer.

25 The imaging beam may be continuous, describing lines or discontinuous, forming individual spots.

The preferred laser is one which provides heat energy to the dye and Nd:YAG lasers have proved suitable.

30 Another preferred method comprises intimately contacting the dye releasing surface of a dye donor film with the first plastics layer, contacting the dye releasing layer with an image creating pattern of thermally activated pins in a thermal printing head such that dye is then imagewise transferred to the plastics

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layer, and diffusing the dye into the plastics layer to a significant depth, allowing marking of the adjacent second layer.

5 Other methods of transferring dyes on to the first plastics layer include:-

1) ink jet imaging means in which the dye is delivered in an ink jet to form the image;

10 2) imaging or printing means in which the diffusible dye is releasably incorporated in a composition which is intended to remain bonded to the surface of the first plastics film, for example

15 a) xerographic toner deposition, the toner releasably incorporating the diffusible dye; in this case the non-diffusible portion of the toner would remain on the surface and the dye would diffuse into the plastic layer;

b) magnetically deposited powders incorporating diffusible dye;

20 3) plotter pens depositing an ink which contains diffusible dye.

25 As an alternative to using conductive heating under pressure to cause diffusion, the or each dye may include a heat radiation absorbing dye, wherein the diffusion step comprises activating the heat absorbing dye to cause the diffusible dye to diffuse. For example, this may be implemented by including an infrared (heat) absorbing dye which is transferred imagewise with the diffusible dye, and then applying IR radiation (e.g. 1060nm Nd:YAG laser or from an incandescent source) to cause local heating in
30 the areas where the IR dye is. The laser heating exposure can be overall or imagewise. The incandescent heating will be overall but in both cases heating will occur only where the IR dye is.

35 As an alternative to incorporating heat radiation absorbing compounds, a source of radiation may be chosen

which will heat the plastic layer by for example the plastic or a compound blended with the plastic absorbing and so becoming hot. Use of radiative heat sources may allow more control of the heating conditions and local heating within the layers than conductive sources.

The second layer will preferably be plastic but may also be a paper plastic laminate or surface treated paper such as plastic coated, resin coated, and highly filled papers which have a smooth surface or simply an ink or printed lacquer layer on a surface of the first layer. The paper may be made of natural or synthetic fibres.

In some cases, particularly where the second layer is ink, a third or further (preferably plastics) layer is provided, the second layer being positioned between the first and third layers, wherein the or each dye is caused to diffuse into all three or more layers.

The plastics materials typically comprise PVC although other materials may also be suitable such as polyesters and polycarbonates. The "PVC" used for security cards which is suitable with the invention need not be pure PVC homopolymer. A small percentage of polymerised vinyl acetate may also be present. This may be included as a copolymer with vinyl chloride. Opacifying pigments may be included in the PVC although the topmost film must normally be transparent.

We have found that approximately 5% by weight of vinylacetate incorporation gives adequate dye diffusing properties with approximately 10% or more giving unsatisfactory results.

The glass temperature of the PVC may also have an effect, with those materials having higher glass transition temperatures showing better results. Commercially available PVC homopolymer of medium molecular weight allows improved image quality with the

dyes which we have used. PVC homopolymer of high molecular weight gives further improved images.

The plastics first layer in the form of a film may cover all or part of the surface to which it is attached.

5 Attachment may be before or after imaging.

Plastics polymeric coatings such as of PVC may be coated on all or part of the surface of the second layer or may be selectively applied such as by screen printing. Plastics coatings may also be applied by depositing a curable lacquer and subsequently curing it by for example exposure to ultraviolet radiation.

10 In this case the plastics polymeric coating will adhere directly to the second layer. Only a portion of the surface need be covered.

15 It is generally desirable that the first and second layers be composed of chemically similar plastics so as to allow high adhesive strength at the interface.

Normally the first plastics layer will be transparent and colourless although it may be tinted. Normally the second plastics layer will be opaque allowing viewing of the completed image through the first substrate.

20 In certain circumstances it may be desirable to employ two transparent plastics layers or a first layer which is opaque but which allows the dyes to diffuse through so as to allow the image to be viewed through the second layer which must be transparent.

Preferably, in the case of a security article, the image is characteristic of the bearer of the article such as a representation of the bearer of the article or a representation of his signature.

30 In accordance with a second aspect of the present invention, a security article comprises two layers in contact, at least one of the layers comprising a first plastics layer which contains an image formed by a

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diffusible dye, the other layer having been marked with the diffusible dye.

Some examples of methods according to the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 illustrates, schematically, apparatus for performing one method according to the invention; and,

Figures 2A and 2B are schematic cross-sections through security cards which have been provided with coloured images according to two different methods according to the invention;

Figure 3 is a cross-section through an example of an identity card;

Figures 4 and 5 are cross-sections through an article before and after lamination respectively; and,

Figure 6 is a cross-section through a triple laminate article

The apparatus shown in Figure 1 comprises a first stock roller 1 on which is provided a stock of a thin, transparent, laminatable PVC tape 11 which is supplied to an imaging station 2. The imaging station comprises a roller 3, a thermal printing head 4 and a dye donor module 5. The dye donor module 5 comprises a stock spool 6, a pair of guide rollers 7, 8 and a take-up spool 9. A length of dye donor film 10 is wound initially around the stock spool 6 and is guided around the guide rollers 7, 8 to the take-up spool 9. The colour dye donor film 10 is of conventional form and comprises a plastics base layer on which is carried a series of transfer dyes having colours cyan, magenta, and yellow repeated throughout its length. An example of a suitable dye donor film is Hitachi colour video printer material Type VY-T50A. For four colour printing a black dye may be transferred in addition to the cyan, magenta,

and yellow. For monochrome images the dye donor film may have any colour.

In operation, as a length of the transparent PVC tape 11 reaches the imaging station 2, the first dye to be transferred, for example yellow, is brought between the thermal head 4 and the roller 3 by rotating the take-up spool 9. This is achieved via conventional control electronics indicated schematically at 12. The control electronics 12 then actuate the thermal head 4 in such a manner that the yellow dye is transferred at the correct places on to the tape 11 corresponding to pixels of an image which is to be provided on the tape. During this process, the tape 11 is stationary while the head 4 is moved (by means not shown) along the tape. Once the yellow dye has been transferred, the take-up spool 9 is activated to bring the next dye into line with the thermal head 4, for example magenta, and the process repeated. The process is again repeated with the cyan dye following which the tape 11 is drawn out from the imaging head towards the lamination rollers, to be described.

The manner in which the thermal head 4 is activated is determined by reference to a digital version of the image to be transferred which is stored in a store 13.

The imaged PVC tape 11 is then drawn through a laminating station 14 where the tape is fusion laminated between a pair of rollers 15, 16 to another PVC tape substrate 17 fed from a second stock spool 18. This second substrate may comprise a single plastics layer or may itself comprise a number of layers which are either already laminated or are laminated by the rollers 15, 16. Fusion lamination takes place at a temperature in the range 130-160°C and under a pressure of about 150lbs per square inch (10.4kPa). The hot, bonded card must then be allowed to cool whilst remaining under pressure in order

to maintain surface gloss and overall flatness of the card. The pressure here may be about 600 lbs per square inch (41kPa). Following lamination, the laminated tape is fed to a cutting station 19 where the tape is cut into individual security articles.

Of course, several variations of this apparatus are possible and for example the imaging station could comprise three printing heads arranged sequentially, each ink being transferred at a separate station. Lamination of sheets may also be undertaken.

In the case of security articles such as security cards each will comprise one or a number of core layers leading to a typical core thickness of 650 μ m. On each side of the core may be superposed a number of relatively thin cover layers leading to a total thickness of core plus cover layers of approximately 750 μ m. It is normal to have only one top layer with a thickness of approximately 100 μ m. For simplicity, we will describe various different methods of providing coloured images on or in these cards by reference to just two layers, a core layer 20 and a thin, transparent cover layer 21.

Figure 2A illustrates the result of carrying out the method defined by the apparatus shown in Figure 1 with the core layer 20 forming part of the laminated substrate fed from the second stock spool 18 while the layer 21 corresponds to the imaged PVC tape 11. As can be seen, the transferred dye, indicated at 22 has diffused into both the core layer 20 and the cover layer 21 during the lamination stage. In the case of security articles, this makes it very difficult to forge such cards where "forgery" refers to the illegal alteration of the articles, in view of the diffusion of the dye into each layer. Furthermore, the diffusion leads to the production of high contrast images with adequate tone gradation and without the need for special release layers

to prevent sticking as in known transfer techniques. In an alternative method the image could be transferred to the core layer 20 and then the transparent layer 21 laminated on to the core layer.

5 Figure 2B illustrates a modified form of the Figure 2A construction in which the layer 21 is reversed relative to the core layer 20 so that the imaged surface of the cover layer 21 is exposed. During the lamination stage, the dye 22 diffuses into and partially
10 through the cover layer 21 and marks the core layer 20 by diffusing into it.

In preferred examples, the surface of the core layer 20 through which the dye diffuses is preprinted with a security print.

15 In a typical thermal transfer process such as that shown in Figure 1, the temperature of the head will be about 200°C while the time to expose all pixels in a line of three inches corresponding to the length of the head is typically about 10ms although it is possible to
20 introduce a grey scale graduation by varying the time per pixel. The total time in practical thermal transfer imaging equipment to expose a 3 inch x 4 inch (ie. 75 mm x 100 mm) area at a density of 150 pixels per inch to all three colours is about 2 minutes.

25 In contrast, a laser induced transfer system is far quicker and enables much higher pixel densities to be achieved, typically of the order of 1000 pixels per inch. Typical temperatures can be up to 300°C with a typical exposure time per line of pixels being about 2 ms with
30 the pixels being exposed serially. This leads to a total time to image a 3 inch x 4 inch (75mm x 100mm) area with all three colours in the order of 12 seconds.

Figure 3 shows a plastic laminate construction with plastic (PVC) layer 30 bearing security printed indicia
35 32, bonded to plastic (PVC) core 31 at interface 33.

Thermally transferred diffusible dye was initially deposited on the surface 34 and then the dye was diffused in by heat forming the image in layer 30 at 35, and also in the ink of the security printed indicia 36 and the underlying layer at 37. Fraudulent removal of the dye is therefore made difficult.

This structure would typically serve as an identity card.

Figure 4 shows a plastic foil 38 bearing security indicia 39 on a surface which has received diffusible dye 40.

Figure 5 shows the layer of Figure 4 laminated to a plastics substrate 41 at interface 42, the dye having been heated and allowed to diffuse into plastic layers 43 and 44, and through the ink 39.

Figure 6 shows three plastic layers bonded together. First layer 46 bearing security printed indicia 47 is bonded at interface 48 to plastic layer 49 which is further bonded at interface 50 to opaque plastic layer 51. Diffusible dye initially deposited on the surface at 52 is diffused into the matrix and stains plastic layers in the shaded area 53 which extends through all three layers and the ink. A different ink printed at 54 inhibits the diffusion of the dye into the underlying layers by absorbing the dye and therefore is marked.

Some Examples of methods according to the invention will now be described.

EXAMPLE 1

A white PVC security card substrate of 650 microns thickness is lithographically printed to impart background security indicia. The PVC substrate contains a small proportion of polyvinyl acetate and contains a white pigment.

A film of PVC laminating film of thickness 100 microns is electronically imaged to give a colour picture

of the card holder. This is achieved by capturing the holder's image on a colour camera and preparing a series of data according to red, green and blue colour components. This data is then used to cause yellow, magenta and cyan dye to be deposited imagewise on the PVC film. The imaging device is a Hitachi thermal printer having a thermal head composed of individually heatable elements, there being 150 per inch. Yellow, magenta and cyan Hitachi thermal colour transfer films are employed as the dye donors.

The imaged surface of the film is then laminated to the security print bearing surface of the substrate for 75 seconds at 140 degrees Centigrade and allowed to cool under pressure. The overall cold-to-cold cycle time is 6 to 8 minutes.

During the heating the dye diffuses across into the PVC core and into the film itself to a depth of at least 20 microns. The film and substrate are thus securely fused together.

The diffusion depths were of the order of 30 to 80 microns.

The laminate is then cut to ISO financial card size to form a card ready to receive embossing with account information.

The construction is tamperproof as any attempt to change the electronically applied image or the security printing will result in inevitable damage to the other.

Magnetic and signature strips may be added during the making of such cards if necessary.

EXAMPLE 2

A white PVC security card substrate of 650 microns thickness is lithographically printed to impart background security indicia. The PVC contains a small proportion of polyvinyl acetate and is pigmented.

5 A film of high softening point PVC of thickness 30 microns is laminated to the security print bearing surface of the substrate for 75 seconds at 140 degrees Centigrade. The total cold-to-cold cycle time is within 6 to 8 minutes.

10 The film surface of the card blank is then electronically imaged to give a colour picture of the card holder. This is achieved by the method in Example 1 except that the dye is transferred to the outer surface of the card by placing yellow, magenta and cyan dye transfer films in sequential intimate contact with the card surface and using laser imaging equipment as described in EP 202811A to cause imagewise dye transfer thereby forming a colour picture of the holder.

15 The card is then heated between heated platens at 150 degrees for 30 seconds to allow the dyes to diffuse into the film towards and beyond the security printed layer. A diffusion depth of about 30 microns was achieved, which is adequate to ensure the dyes penetrate to the security layer.

20 The diffusion conditions are generally arranged to be sufficient that the card suffers no significant distortion from the plane.

25 The imaged laminate is then cut to ISO financial card size to form a financial card ready to receive embossing with account information.

The construction is tamperproof as any attempt to change the electronically applied image or the security printing will result in inevitable damage to the other.

30 The construction is also very convenient to use as the electronic image is applied to a card blank which can be produced in multiples with minimal further processing. The completed card offers a very high level of security.

EXAMPLE 3

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This is conducted as Example 2 except that the security printing is applied to the underside, that is the laminatable side, of the film rather than the substrate.

5 Again this results in a secure financial card with the dyes having diffused in from the outside to a depth of at least 30 microns in 30 seconds, sufficient to dye the security printed layer. Any lateral movement of the dye is minor and does not adversely affect the appearance
10 of the final image.

EXAMPLE 4

This is conducted as Example 2 except that instead of a film being laminated to the card, a coating of polyvinyl chloride is applied by screen printing at
15 thicknesses of 10, 20, 30, 50 and 100 microns wet. This coating covered all of the surface of the card. After drying the PVC coating is imaged as in Example 2 and the imaged card heated at 150 degrees Centigrade for 30 seconds. The dye penetrates to a depth of at least 30
20 microns into the card, resulting in a secure card.

EXAMPLE 5

A film of 100 micron thick clear PVC is security printed in the normal manner. The security printed side of the film is then coated with a 20 micron thick dye
25 receiving layer of polyvinyl chloride. After drying this coated film is then imaged with a thermal printing head as in Example 1.

The composite film is then laminated to 750 micron PVC substrate bearing security indicia on its laminatable
30 surface, at 150 degrees Centigrade for a few minutes. The surface of the composite film bearing the electronic image of the holder is used as its laminating surface. The thermally applied dyes diffuse through the coating into the film and also into the substrate. Thus this
35 format offers increased security as there are two

separate security printed layers each of which has received the diffused dye image.

5 The completed card may be given a further electronic dye image e.g. of the signature of the holder, by applying the diffusible dyes to the outer surface of the card and then heating the card for sufficient time to cause diffusion.

10 In order to measure the depths of dye penetration typical yellow, magenta and cyan dyes were sequentially deposited by means of a Hitachi thermal head printer onto PVC substrates to form parallel black lines of 0.7mm width.

15 The PVC substrates were 80 micron thick transparent PVC film (supplied by the Stauffen Company) and the same material coated with a 20 micron dry thickness coating of high molecular weight PVC homopolymer (supplied by BDH Ltd., Type 29784). The coating was applied by solvent deposition.

20 Thermal imaging as described above was then conducted. For the uncoated substrate the side which was to be coated for the comparison was imaged. For the coated substrate the coated side was imaged.

25 The imaged substrates were then laminated with their printed side outwards onto PVC card base stock of thickness 650 microns.

30 After lamination under a variety of conditions the imaged surface was physically removed to increasing depths in order to give a comparative method of measuring dye penetration depth. The depth was taken at the point where the density of dye started to decrease noticeably. Some of the dye however penetrated to a greater depth at lower density but at such a density that would still cause difficulties for fraudulent alteration.

35 The depths were measured by use of Talysurf Ltd. surface profile measuring equipment.

Results are recorded in Table 1 which gives two measurements for two samples and their average.

As expected the diffusion depth was found to increase with time and temperature. The depth of diffusion was generally about two to four times greater through the coated PVC.

The dyes were measured here to have penetrated by at least fifty percent more than was measured on equivalent samples measured by inspecting sections by electron microscopy.

The results show that significant diffusion depths can be achieved during lamination. The results in the table also show that the first substrate coated layers allow deeper diffusion than laminate films under the same conditions. This can have considerable advantages.

TABLE 1

DYE DIFFUSION DEPTH BY ENGRAVING AND TALYSURF TRACING

Card No.	Print on Uncoated (UC) or Coated (C) PVC	Lamination Conditions		Diffusion Depth (microns)		
		Temp (°C)	Time (secs)	Trace A	Trace B	Av.
25	1 UC	155	10	9 9	9 7	8.5±1
	2 C	155	10	14 16	19 18	16.8±2.2
	3 UC	155	30	9 8.5	9 8	8.6±0.5
	4 C	155	30	38 40	32 32	35.5±4
30	5 UC	180	10	15 17	14 16	15.5±1.3
	6 C	180	10	34 32	44 48	39.5±8
	7 UC	145	75	34 34	26 28	30.5±4
	8 C	145	75	80 80	62 65	71.8±10

Investigations have shown that incorporating an infra-red absorber in the dye it is possible to promote differential absorption between written and unwritten areas of PVC by ensuring that some infra-red absorber is transferred with the dye from the carrier or donor sheet. If this absorber is sufficiently sensitive and does not degrade upon transfer, the dye-written areas of the card will preferentially absorb radiation (of the selected wavelength) and therefore differential heating will occur. By differentially heating the specific areas required in this way it is possible to avoid distorting or otherwise altering the condition of the bulk of the card.

CLAIMS

1. A method of providing an image on an article including at least a first plastics layer, the method comprising transferring portions of at least one
5 diffusible dye onto the first plastics layer, the portions being selected so as to generate a representation of the image on the layer; and causing the or each dye to diffuse into and partially remain in the first layer and at least to mark a second layer in
10 contact with the first layer.
2. A method according to claim 1, wherein the or each dye diffuses into both layers.
3. A method according to claim 1 or claim 2, wherein the second layer comprises pre-printed indicia.
- 15 4. A method according to claim 3, wherein the pre-printed indicia are carried on a plastics substrate, the or each dye diffusing partially through the pre-printed indicia into the plastics substrate.
5. A method according to any of the preceding claims, wherein the second layer is a plastics material.
- 20 6. A method according to claim 5, wherein the or each layer comprises a PVC containing material.
7. A method according to any of the preceding claims, wherein the diffusion step comprises applying heat for a
25 predetermined time to the first and second layers.
8. A method according to any of the preceding claims, wherein the diffusion step comprises causing at least the first plastics layer to absorb radiation and thereby generate heat.
- 30 9. A method according to any of the preceding claims, wherein the first layer is fusion laminated to the second layer, the at least partial diffusion of the or each dye being caused by the lamination step.

10. A method according to claim 9, wherein the lamination step includes allowing the bonded laminate to cool under pressure.

5 11. A method according to any of claims 8 to 10, wherein the first and second layers are heated to a temperature of 130°C-160°C and subjected to a pressure of 300-600 lbs per square inch (21 to 41 kPa) for up to a minute.

12. A method according to any of the preceding claims, wherein the surface of the first layer carrying the transferred dye or dyes contacts the second layer.

10 13. A method according to any of the preceding claims, wherein the first and second layers are placed in contact after the transferring step.

14. A method according to any of the preceding claims, wherein the or each dye diffuses into at least the first layer to a depth of greater than 5µm.

15 15. A method according to claim 14, wherein the or each dye diffuses to a depth of at least 10µm.

16. A method according to claim 15, wherein the or each dye diffuses to a depth of at least 50µm.

20 17. A method according to any of the preceding claims, wherein the article further comprises a third plastics layer, the second layer being positioned between the first and third layers, wherein the or each dye is caused to diffuse into all three layers.

25 18. A method according to any of the preceding claims, wherein the or each dye is transferred onto the first layer from a carrier.

19. A method according to claim 18, wherein a radiation beam is used to cause the portions of dye to transfer onto the first layer.

30 20. A method according to claim 19, wherein the radiation beam is a laser beam or a thermal head.

21. A method according to any of the preceding claims, wherein portions of more than one dye are transferred on

to the first layer so as to generate a multi-coloured image.

22. A method according to any of the preceding claims, wherein the or each dye is intimately associated with a heat radiation absorbing dye, wherein the diffusion step
5 comprises activating the heat absorbing dye to cause the diffusible dye to diffuse.

23. A method according to any of the preceding claims, wherein the article comprises a security article, the
10 image defining an individual identification.

24. A method according to claim 23, wherein the image is characteristic of the bearer of the article.

25. A method according to claim 23 or claim 24, wherein the image is a serial number.

15 26. A security article comprising two layers in contact, at least one of the layers comprising a first plastics layer which contains an image formed by a diffusible dye, the other layer having been marked with the diffusible dye.

20 27. A security article according to claim 26 which has been made by a method according to any of claims 1 to 25.

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Fig. 1.

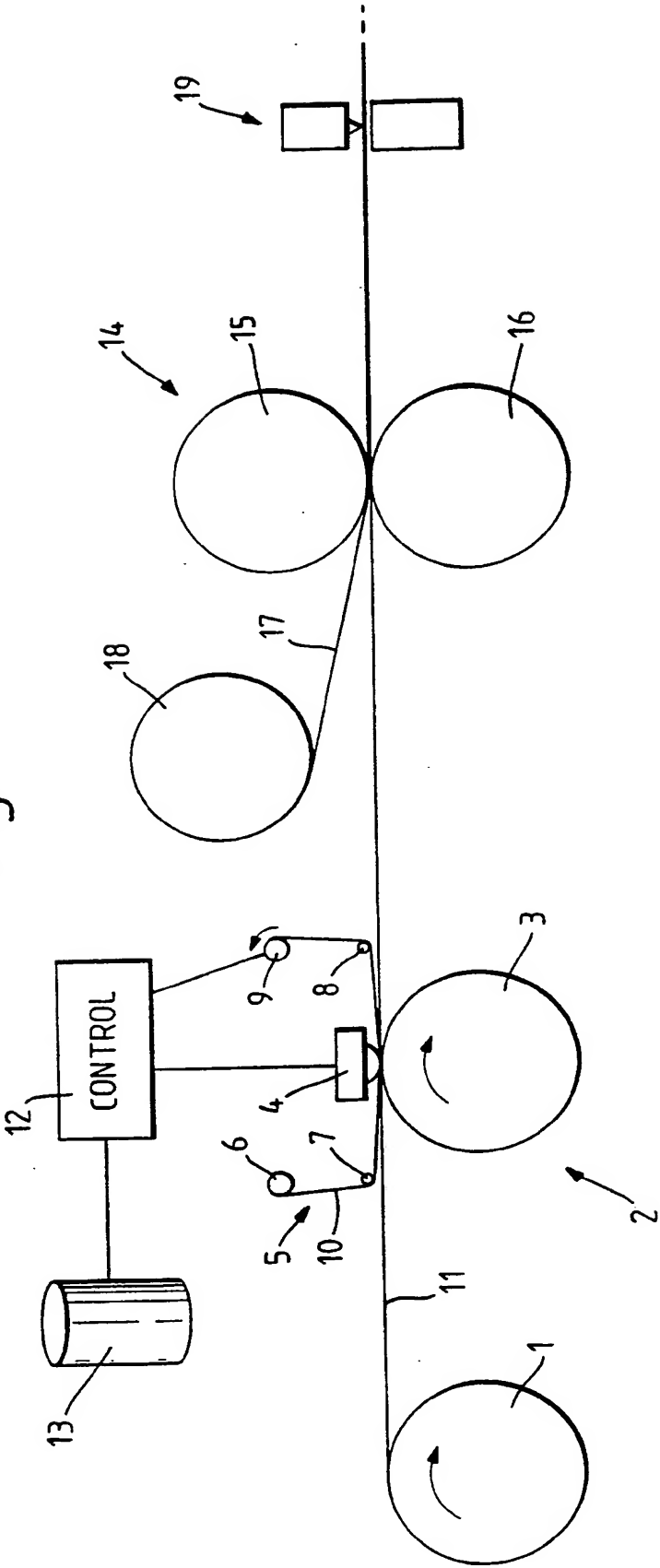


Fig. 2(B)

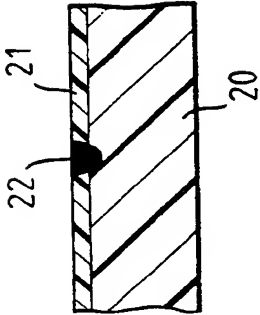
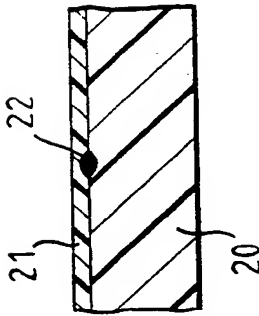


Fig. 2(A)



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Fig. 3.

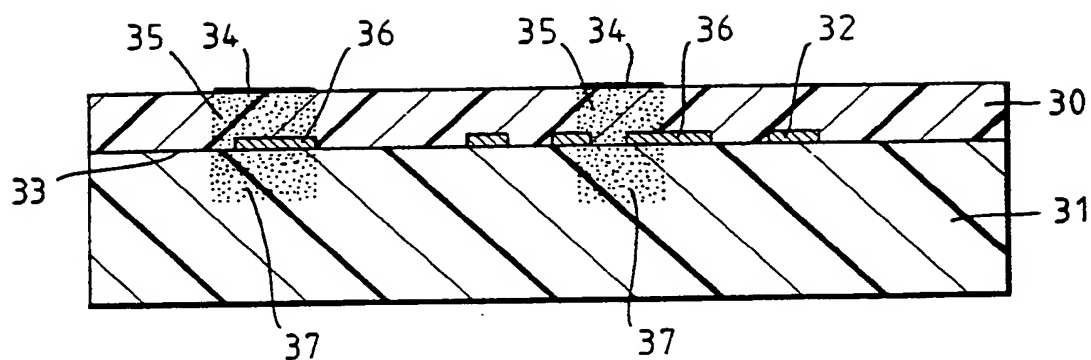


Fig. 4.

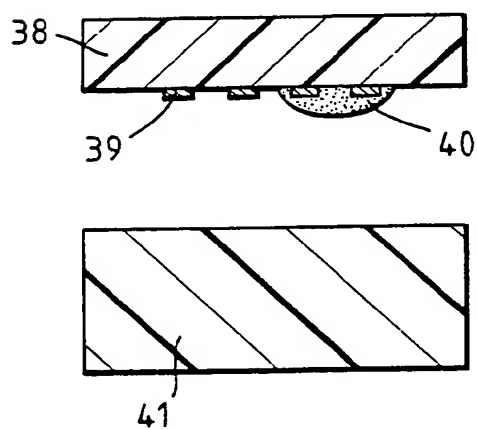


Fig. 5.

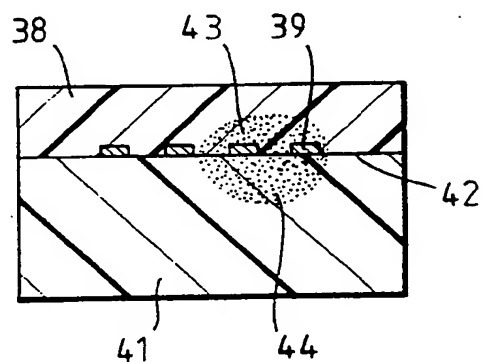
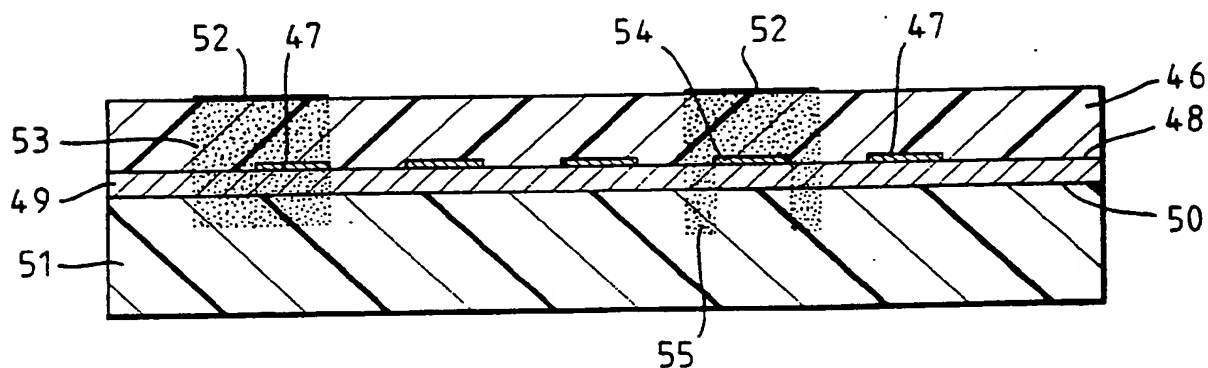


Fig. 6.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 89/01375

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC ⁵ : B 41 M 1/30, B 41 M 5/26, B 41 M 3/14																				
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Minimum Documentation Searched ⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border-bottom: 1px solid black;">Classification System</th> <th style="border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="padding: 5px;">IPC⁵</td> <td style="padding: 5px;">B 41 M 1/00, B 41 M 3/00, B 41 M 5/00</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched ⁸</div>			Classification System	Classification Symbols	IPC ⁵	B 41 M 1/00, B 41 M 3/00, B 41 M 5/00														
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IPC ⁵	B 41 M 1/00, B 41 M 3/00, B 41 M 5/00																			
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border-bottom: 1px solid black;">Category ⁹</th> <th style="border-bottom: 1px solid black;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 10%; border-bottom: 1px solid black;">Relevant to Claim No. ¹³</th> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">US, A, 4059471 (J.M. HAIGH) 22 November 1977 see the whole document --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-27</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">US, A, 2721821 (K.S. HOOVER) 25 October 1955 see column 2, lines 10-13; column 3, lines 9-16; claims --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-27</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">CH, A, 522510 (H.L. PONCIN) 30 June 1972 see the whole document --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-27</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">Patent Abstracts of Japan, vol. 11, no. 241 (M-614)(2688), 7 August 1987, & JP, A, 6253887 (RICOH CO. LTD) 9 March 1987 see abstract --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-27</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">EP, A, 0106663 (XEROX CORP.) 25 April 1984 see page 5, lines 9-25; claims --</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-27</td> </tr> </table>			Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	US, A, 4059471 (J.M. HAIGH) 22 November 1977 see the whole document --	1-27	X	US, A, 2721821 (K.S. HOOVER) 25 October 1955 see column 2, lines 10-13; column 3, lines 9-16; claims --	1-27	X	CH, A, 522510 (H.L. PONCIN) 30 June 1972 see the whole document --	1-27	X	Patent Abstracts of Japan, vol. 11, no. 241 (M-614)(2688), 7 August 1987, & JP, A, 6253887 (RICOH CO. LTD) 9 March 1987 see abstract --	1-27	X	EP, A, 0106663 (XEROX CORP.) 25 April 1984 see page 5, lines 9-25; claims --	1-27
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X	EP, A, 0106663 (XEROX CORP.) 25 April 1984 see page 5, lines 9-25; claims --	1-27																		
¹⁰ Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "A" document member of the same patent family																		
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;"> Date of the Actual Completion of the International Search <div style="text-align: center; font-weight: bold;">26th January 1990</div> </td> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;"> Date of Mailing of this International Search Report <div style="text-align: center; font-weight: bold;">01.03.90</div> </td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 5px;"> International Searching Authority <div style="text-align: center; font-weight: bold;">EUROPEAN PATENT OFFICE</div> </td> <td style="border-bottom: 1px solid black; padding: 5px;"> Signature of Authorised Officer <div style="text-align: center;"> <div style="text-align: right; font-weight: bold; margin-top: 5px;">T.K. WILLIS</div> </div> </td> </tr> </table>			Date of the Actual Completion of the International Search <div style="text-align: center; font-weight: bold;">26th January 1990</div>	Date of Mailing of this International Search Report <div style="text-align: center; font-weight: bold;">01.03.90</div>	International Searching Authority <div style="text-align: center; font-weight: bold;">EUROPEAN PATENT OFFICE</div>	Signature of Authorised Officer <div style="text-align: center;"> <div style="text-align: right; font-weight: bold; margin-top: 5px;">T.K. WILLIS</div> </div>														
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
X,Y	EP, A, 0097528 (HLH CORP.) 4 January 1984 see page 1, line 18 - page 3, line 21; page 4, line 26 - page 5, line 8; claims	1-27
Y	EP, A, 0121323 (COLOUR ACTIVATED TRANS-ILLUMINATION SYSTEMS CO.) 10 October 1984 see the whole document (cited in the application) & WO, A, 8403257	1-27
A	Product Licensing Index, no. 96, April 1972, Silk screen dyeing of films with disperse dyes page 31, abstract no. 9602 see the whole abstract -----	1-27

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

GB 8901375
SA 32456

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The members are as contained in the European Patent Office EDP file on 16/02/90
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		US-A- 4202663	13-05-80
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		JP-A- 59064385	12-04-84
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		WO-A- 8403257	30-08-84

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